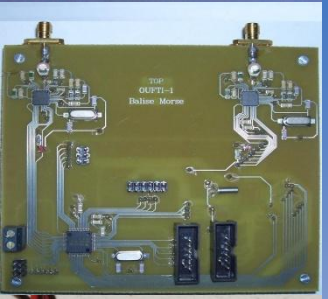
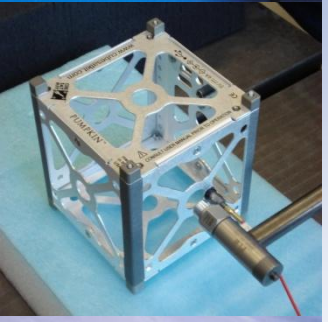




# OUFTI - 1

**The CubeSat developed at the University of Liège, BELGIUM**


Vincent Beukelaers, Dept. of Aerospace & Mechanical Engineering, ULg

Johan Hardy, Gramme Institute

François Mahy, Dept. of Electrical Engineering & Computer Science, ULg

L. Chiarello, N. Evrard, S. Hannay, R. Henrard, L. Jacques, P. Ledent, G. Pierlot, D. Teney, P. Thirion, J. Wertz

Université de Liège

# Project overview

- 3 schools of engineering

Université de Liège

- 13 full-time master-thesis students

- 3 payloads
  - New radio-communication system
  - High-performance solar cells
  - Innovative electrical power system

D-STAR

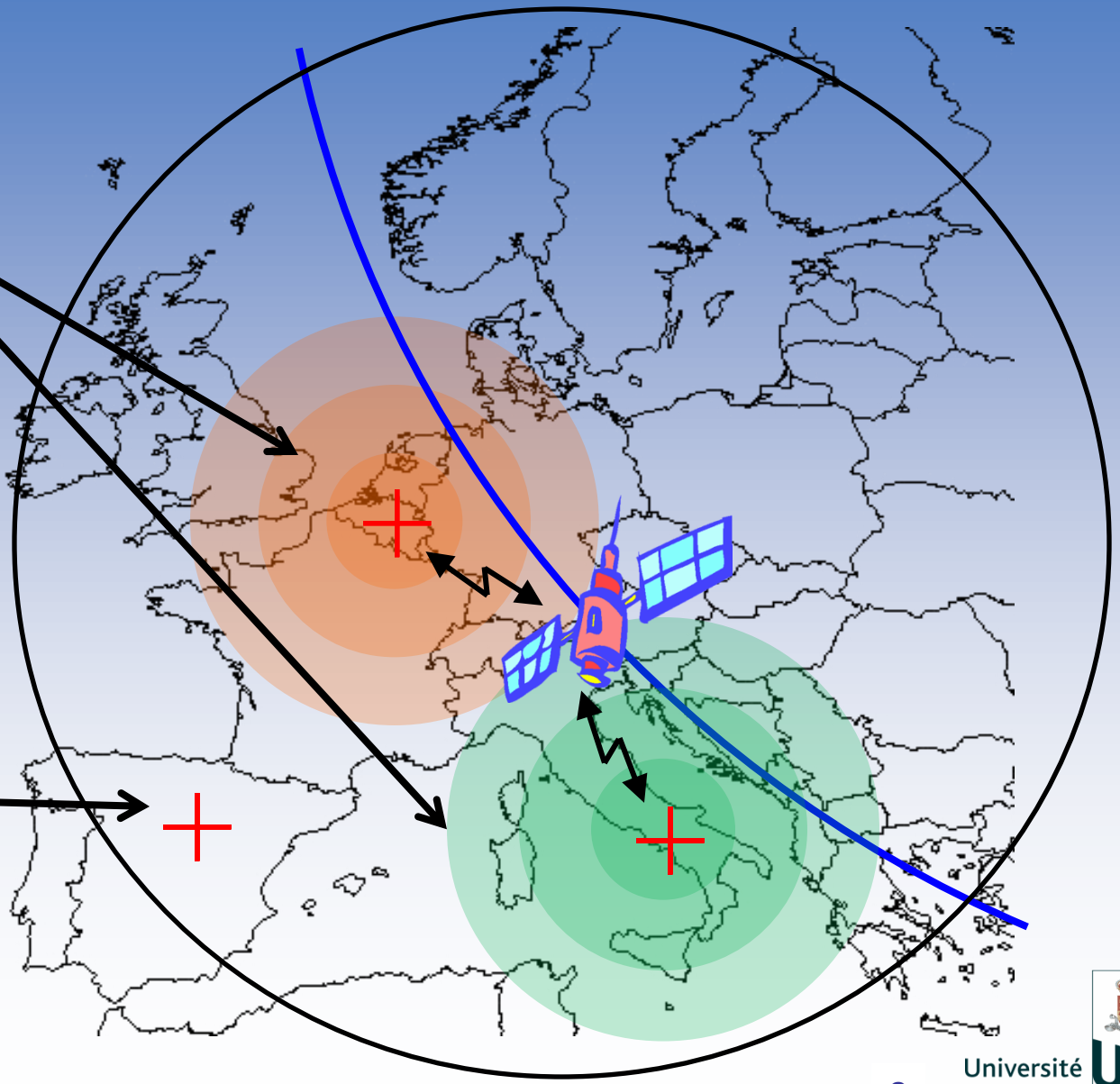
AZURSPACE SOLAR POWER GMBH

ThalesAlenia Space

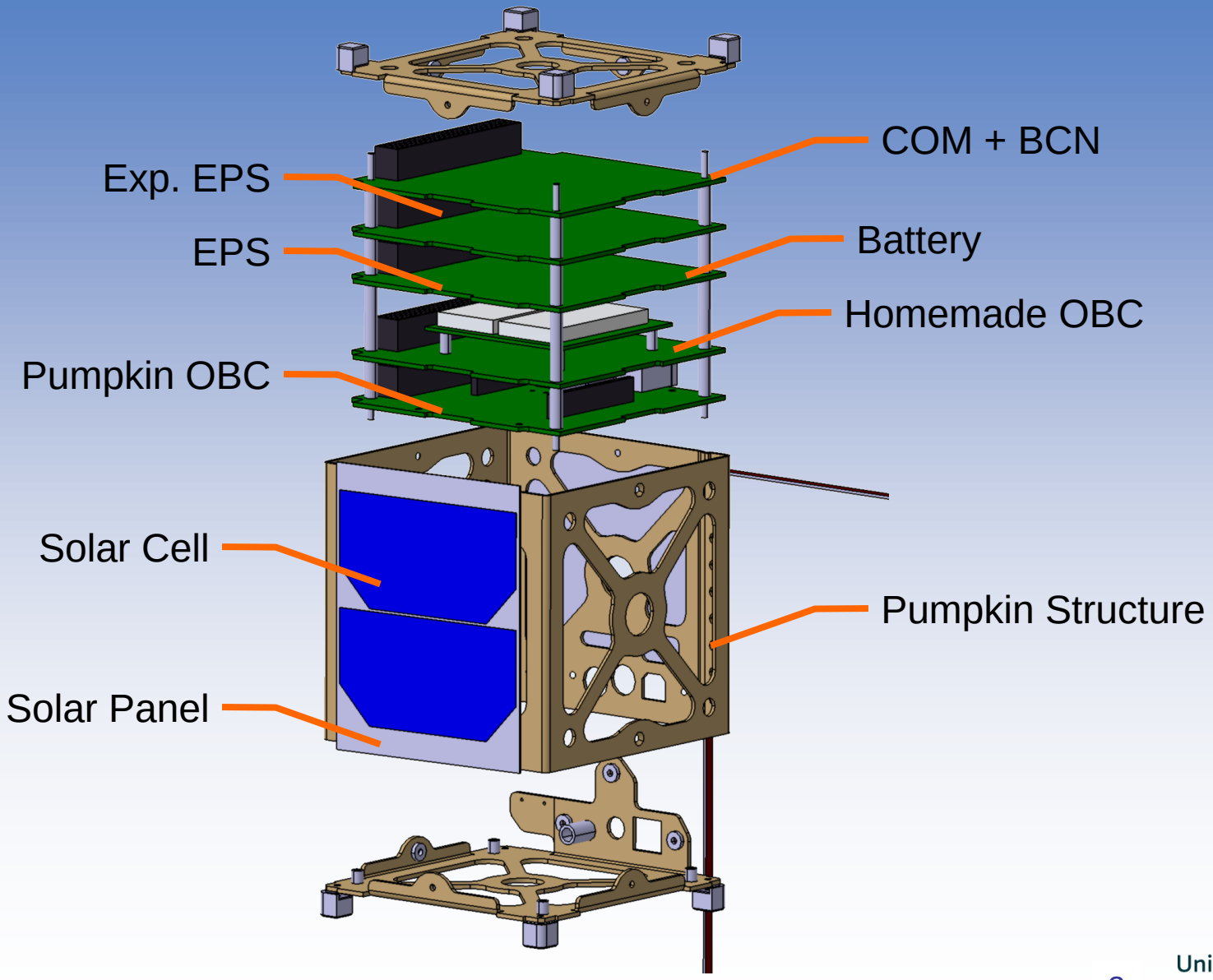
# Mission: D-STAR in Space

- 2 system-selected doppler-compensated coverage zones
  - ULg for control
  - Dynamically determined

- Personnal doppler – compensation possible within OUFTI-1 coverage zone



# Exploded view of CubeSat

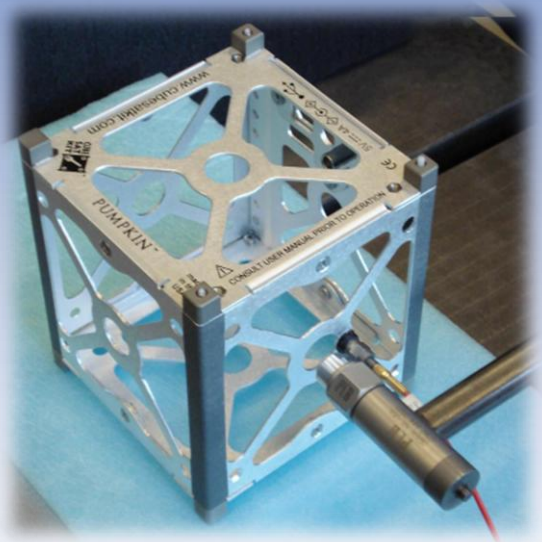


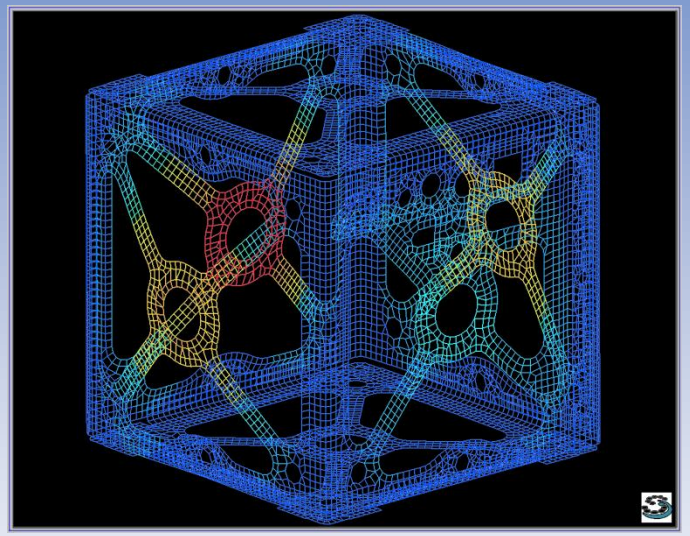
# STRU & MECH

## STRUCTURE

• Preliminary vibrations tests :

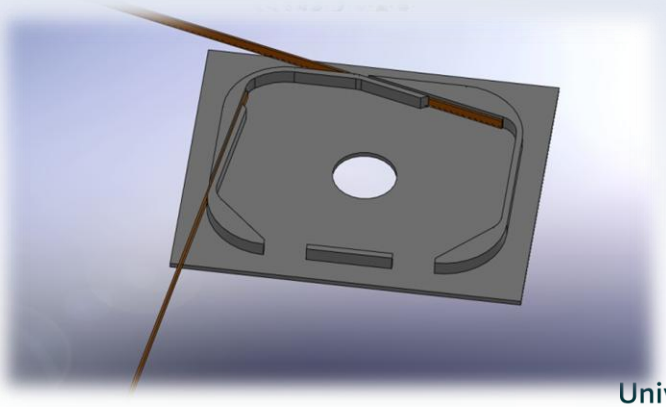
Good correlation between FEM and experimental results
(1st frequency above 500Hz)



## MECHANISMS

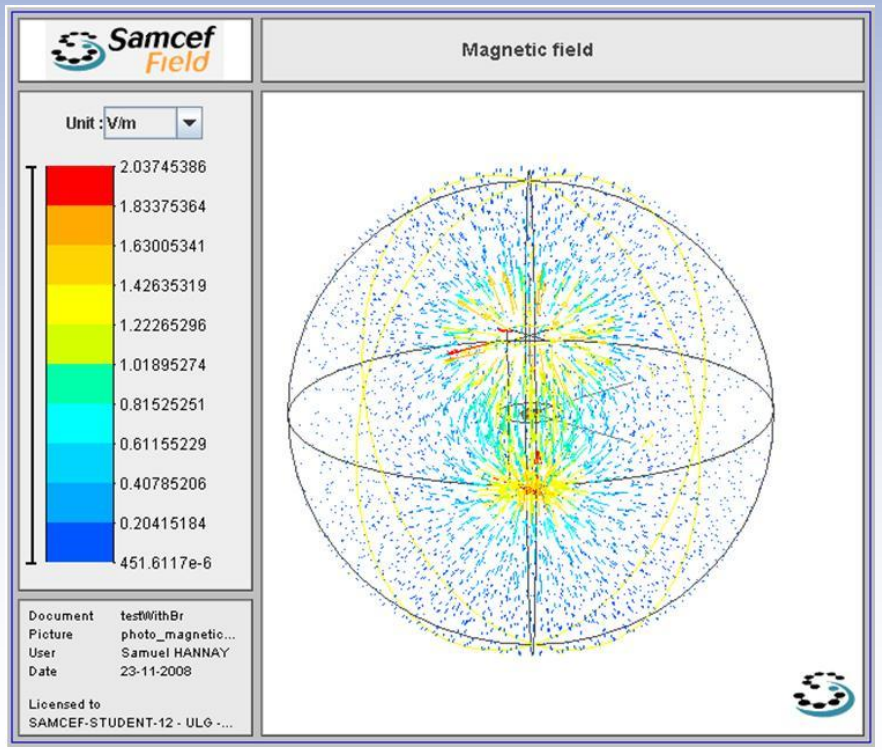
• One face dedicated to antenna deployment mechanism

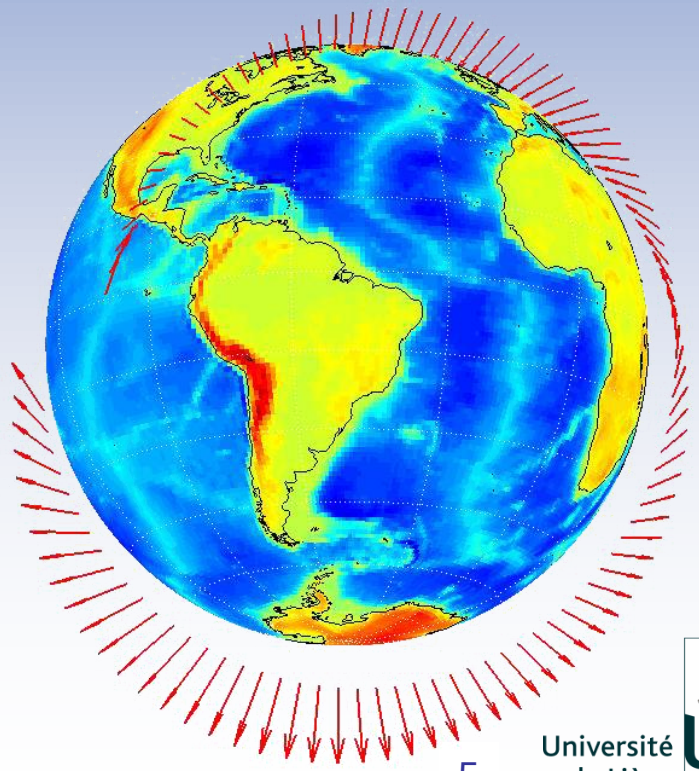


# ADCS

- Fully passive
- Permanent magnet aligned with Earth's magnetic field
- Hysteretic materials system to damp rotation

| Perturbation torques | Values [N.m] |
|---|---|
| Gravity gradients | $10^{-10}$ |
| Aerodynamic torques | $5.\ 10^{-8}$ |
| Solar radiation pressure | $5.\ 10^{-9}$ |
| Magnetic torque | $10^{-10}$ |
| **Magnet torque** | $10^{-5}$ (1cm³ of Alnico-5) |

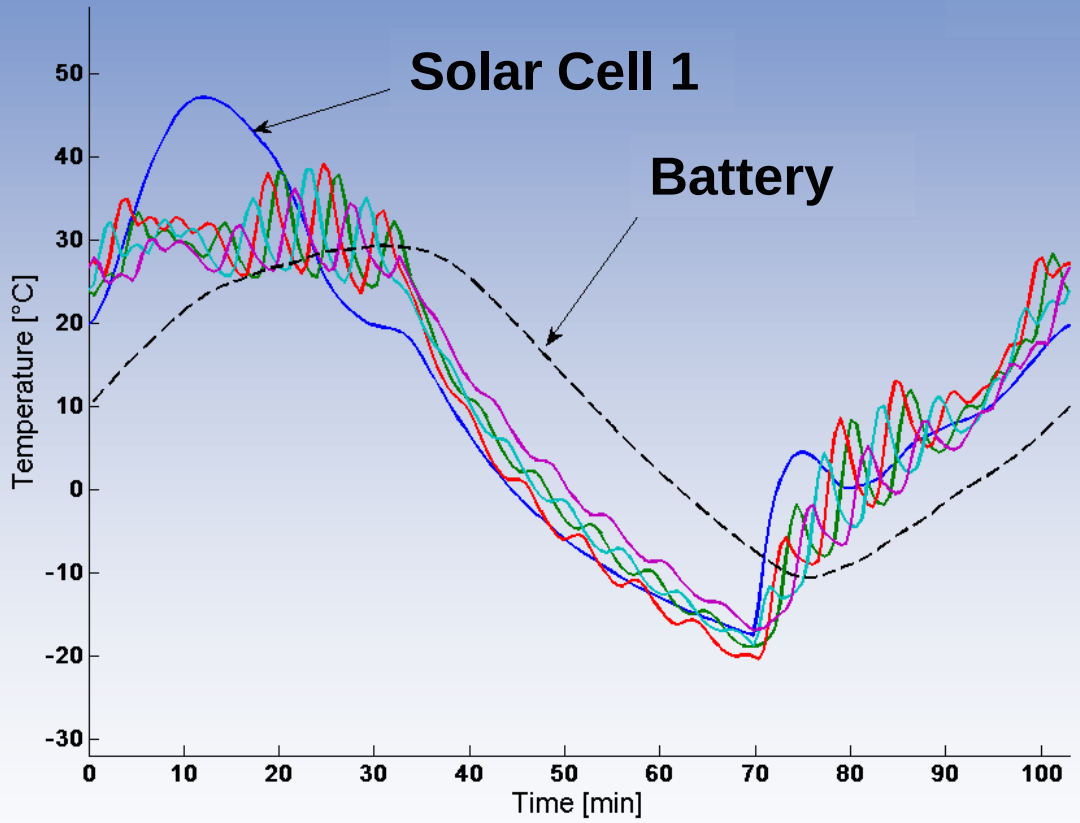


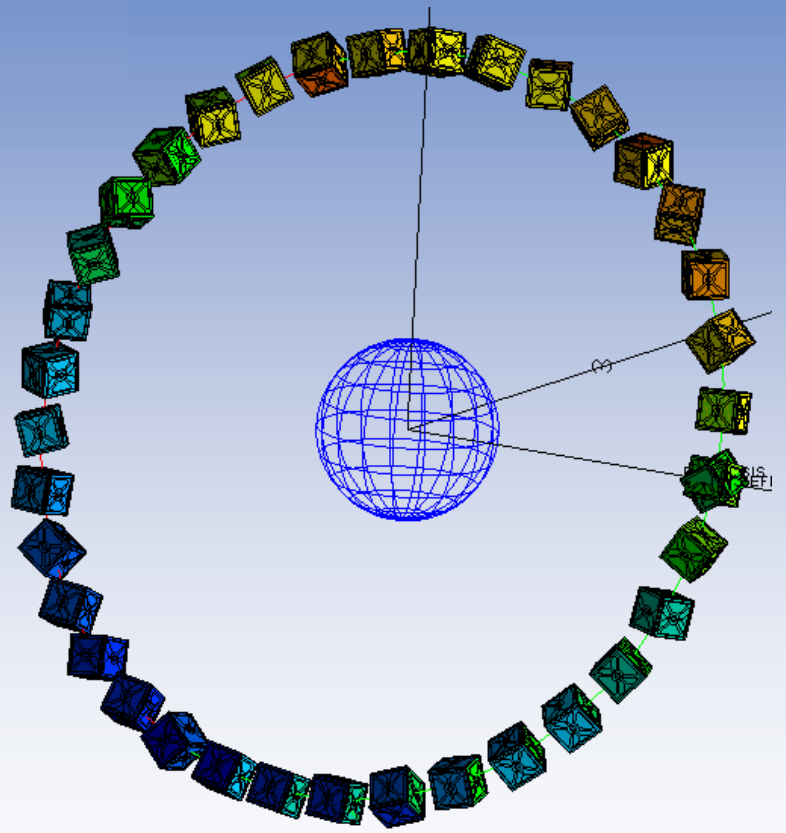




Université de Liège

# THER

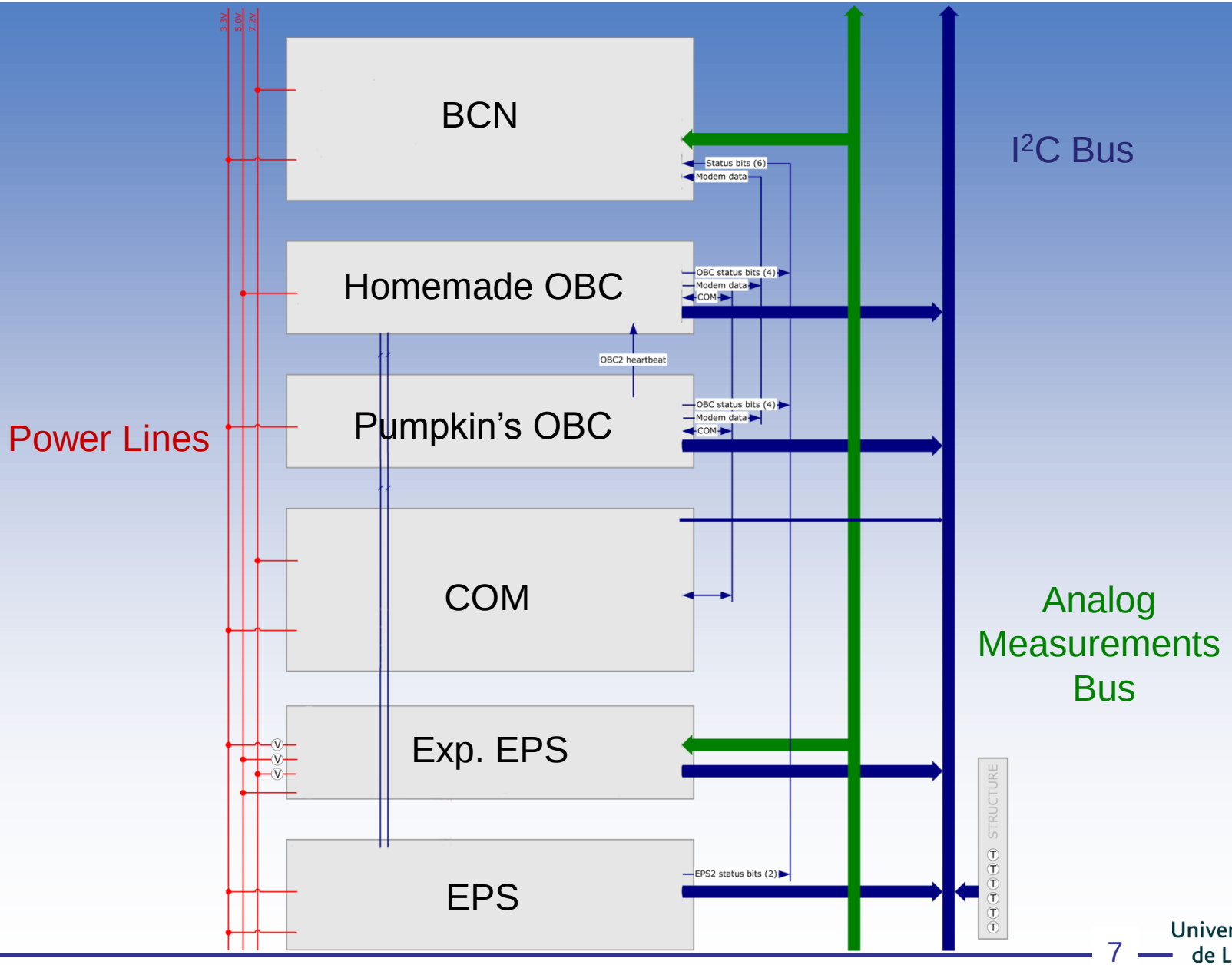
- ESATAN/ESARAD model
- Active system for batteries



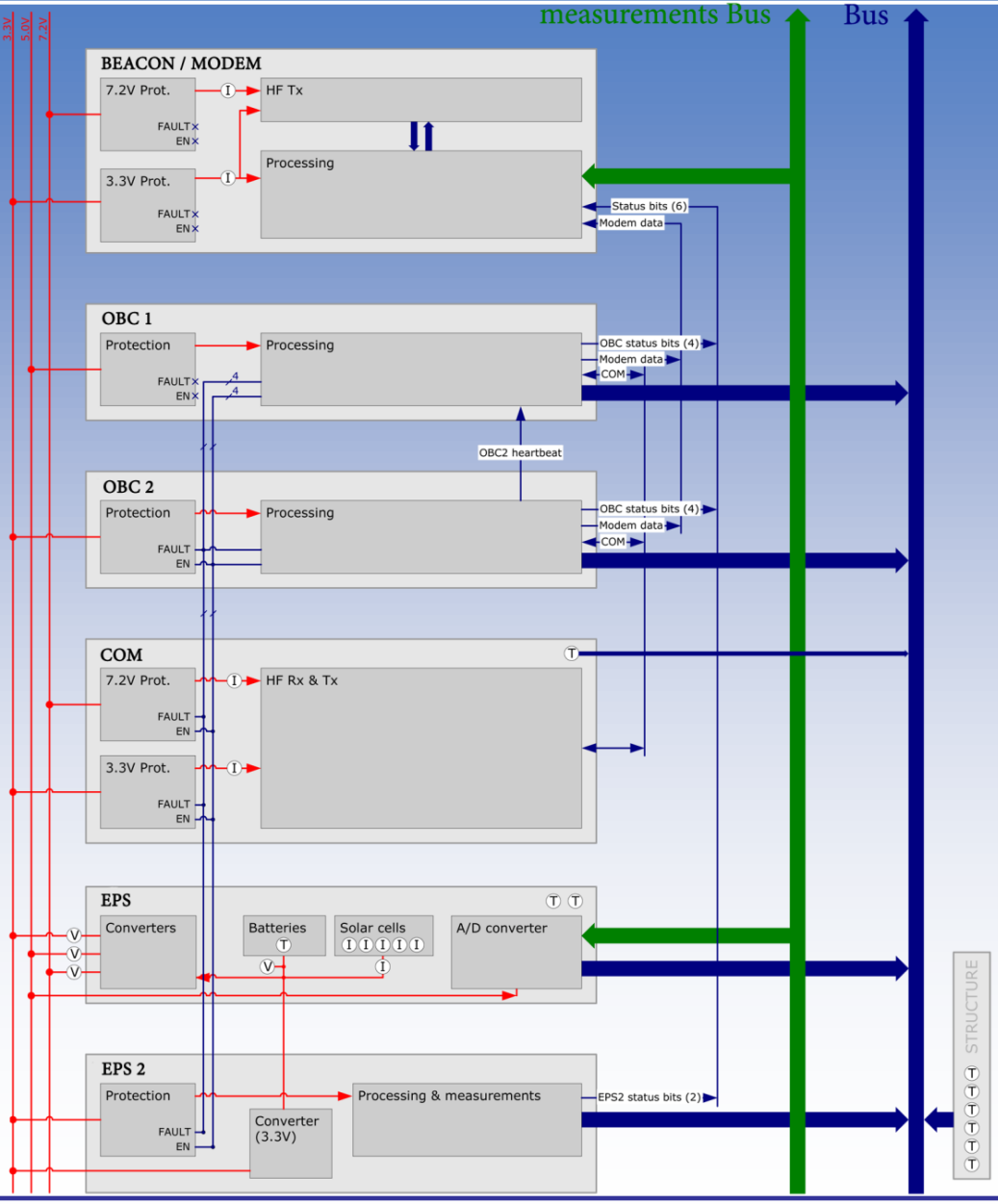



- 6 days of test at Centre Spatial de Liège scheduled for spring 2009

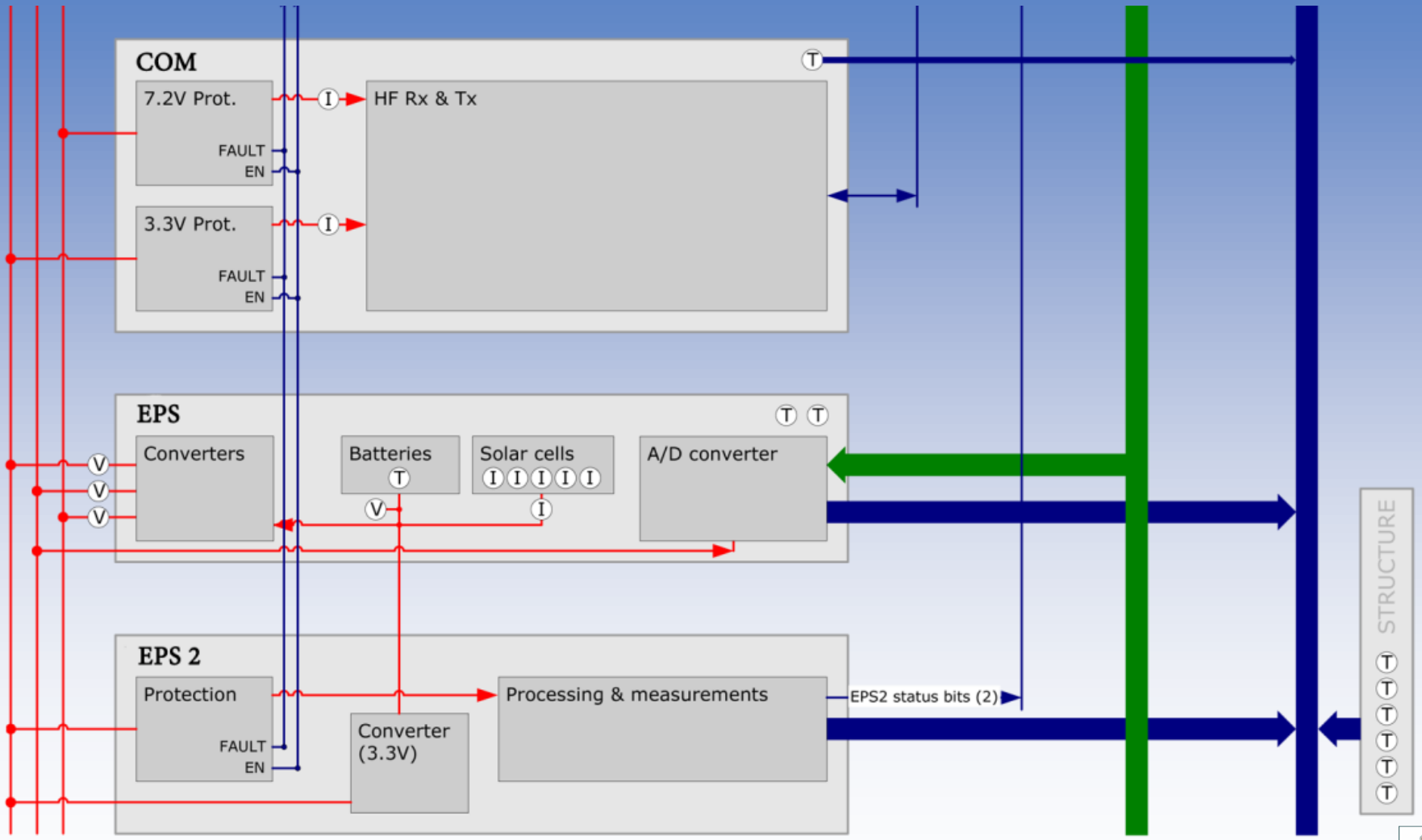
# Architecture (1)



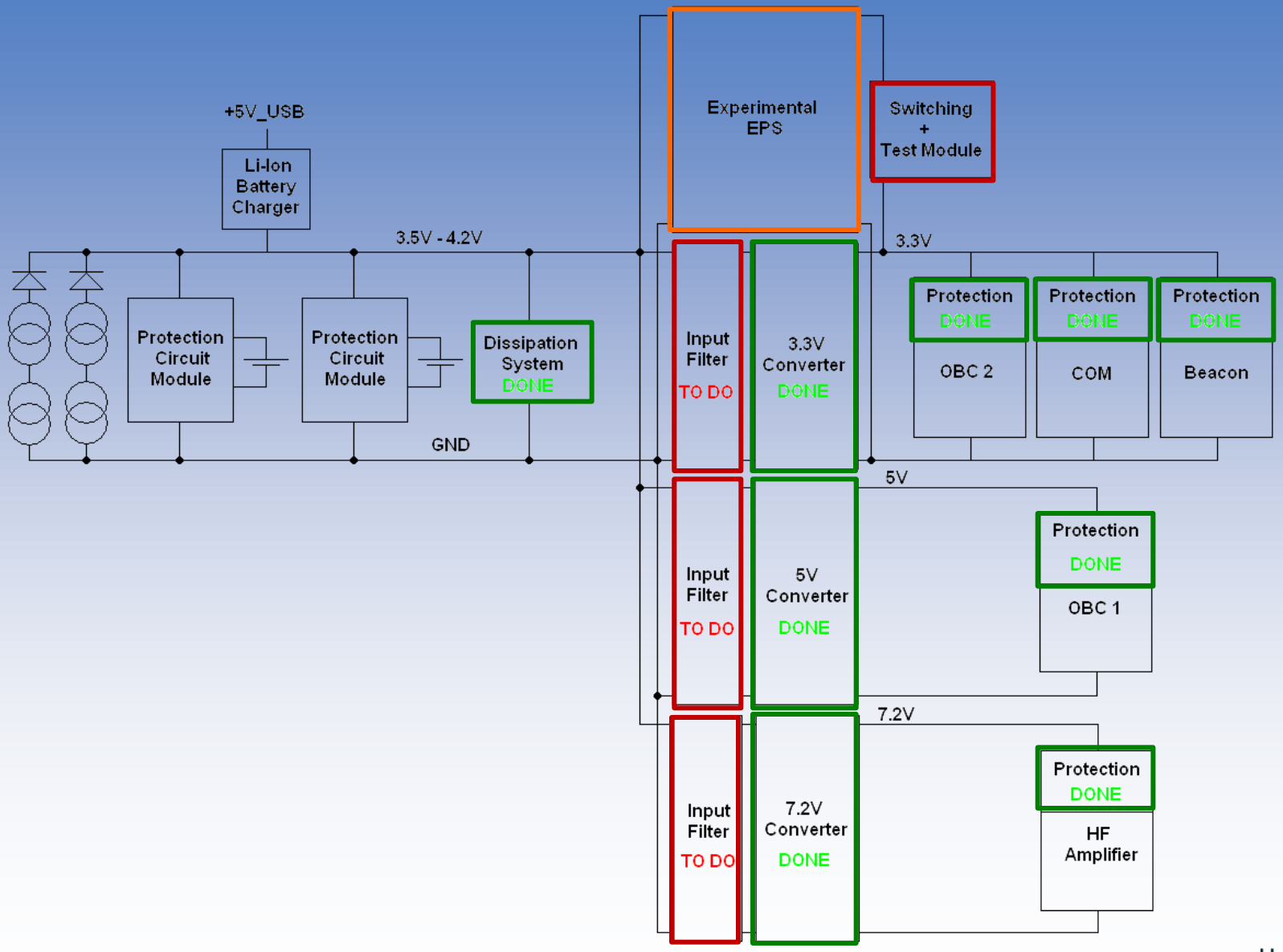
# Architecture (2)



# Measurements



# EPS


+5V_USB
Li-Ion Battery Charger
3.5V - 4.2V
Protection Circuit Module
Protection Circuit Module
Dissipation System DONE
GND
Experimental EPS
Switching + Test Module
Input Filter TO DO
3.3V Converter DONE
3.3V
Protection DONE
OBC 2
Protection DONE
COM
Protection DONE
Beacon
Input Filter TO DO
5V Converter DONE
5V
Protection DONE
OBC 1
Input Filter TO DO
7.2V Converter DONE
7.2V
Protection DONE
HF Amplifier

# OBC (1)

- Main functions
  - Perform the initial operations of satellite
  - Provide a power supply management for sub-systems
  - Handle telecommands from ground
  - Gather and store the various measurements
  - Send telemetry

# OBC (2)

- Hardware: 2 completely redundant computers
  - Pumpkin's OBC used as a backup, in case the other one fails
  - Homemade OBC:
    - Based on TI's MSP430
    - Compatible with Pumpkin's commercial OBC (FM430)
    - Prototype currently under the soldering iron
- Software
  - Use of FreeRTOS
  - High-level software design in progress
  - Many subroutines and drivers already programmed

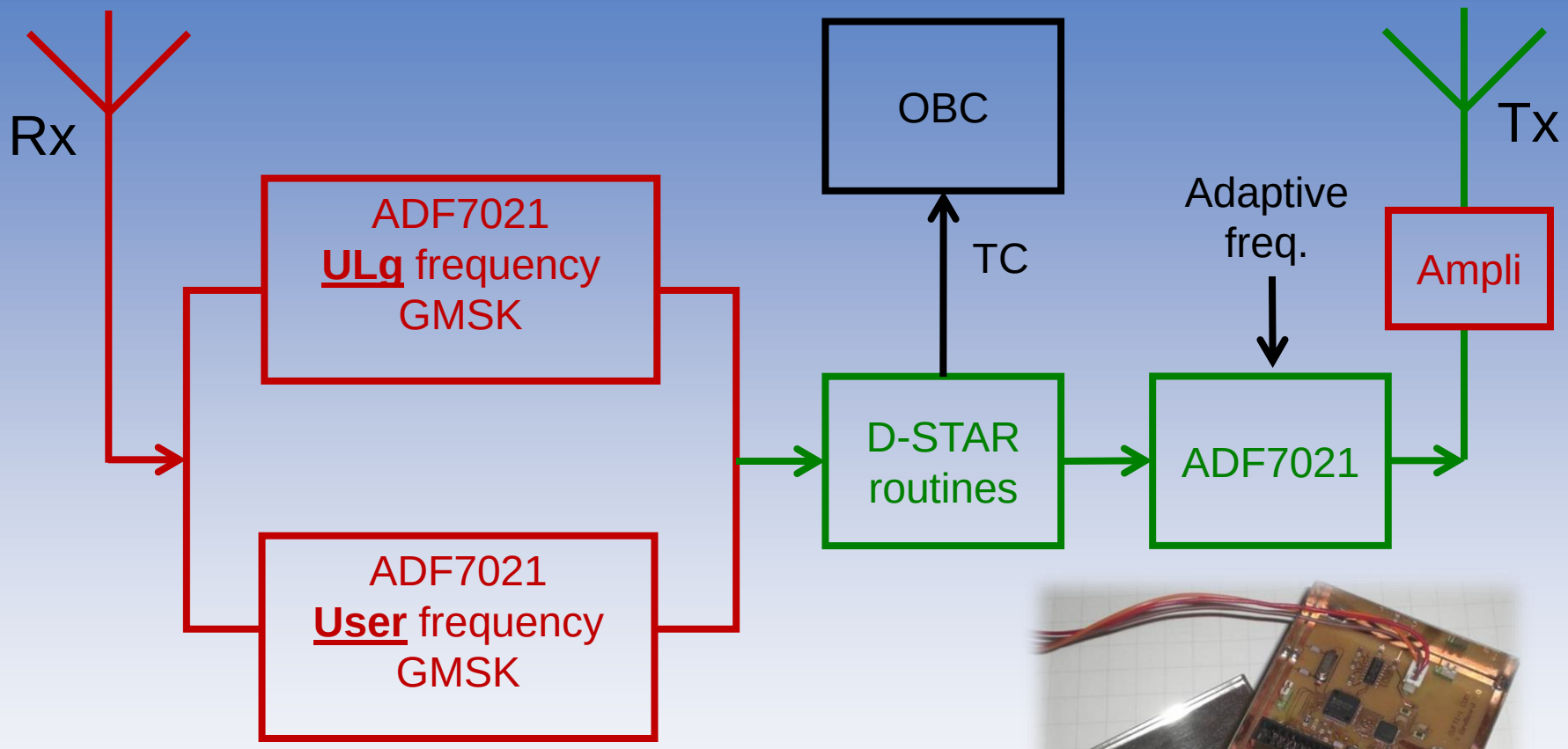
# D-STAR review

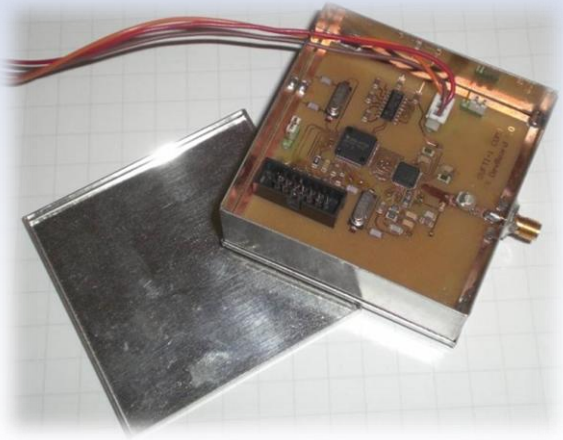
☞ **Digital Smart Technologies for Amateur Radio**

- Simultaneous voice & data transmission (e.g. GPS data)
- Complete routing capacity, including roaming
- 3 frequencies and 2 data rates

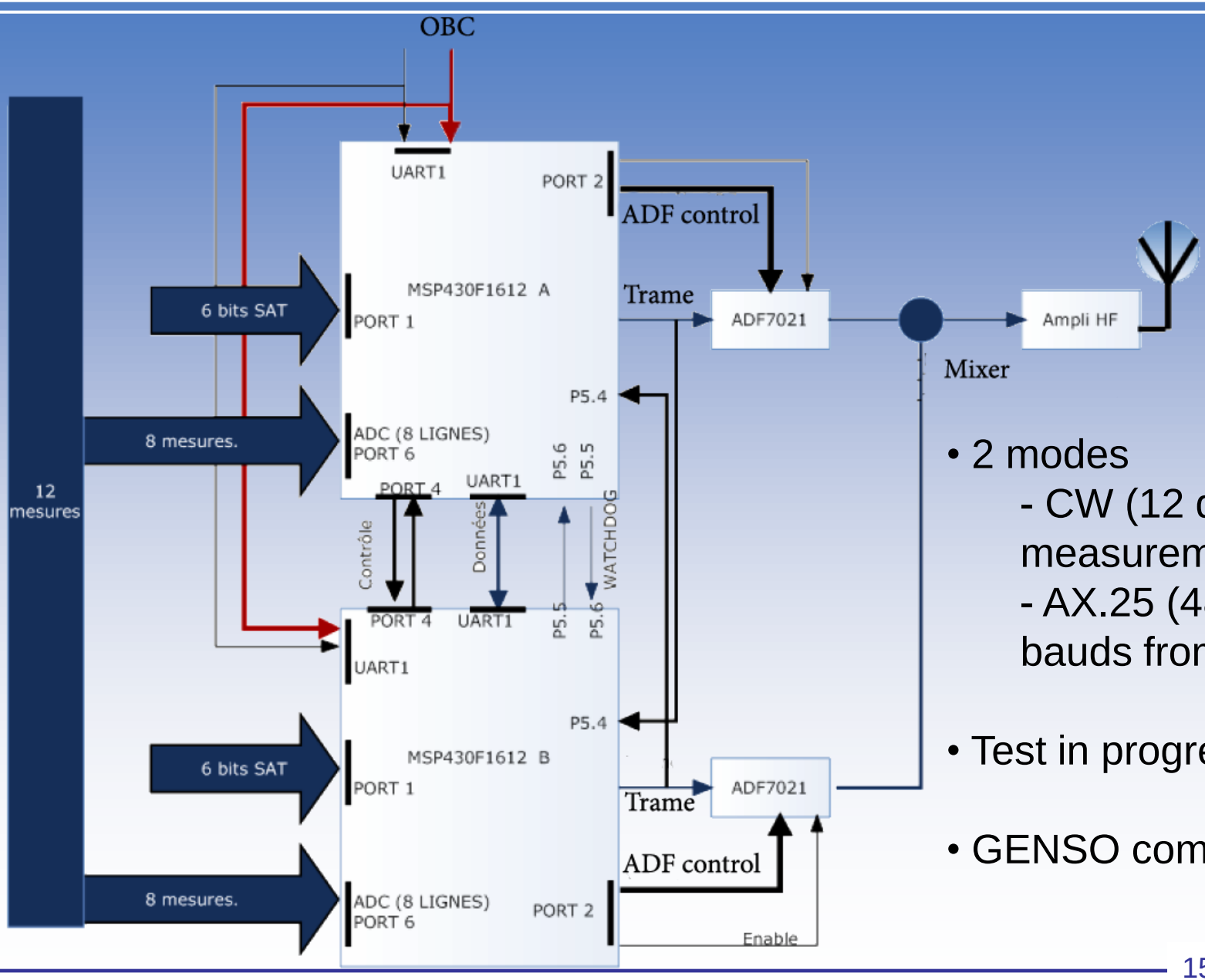
| | |
|---|---|
| - VHF: 144 MHz (2m) | 4.8 kbit/sec |
| - UHF: 435 MHz (70cm) | 4.8 kbit/sec |
| - SHF: 1.2 GHz (23cm) | 4.8 kbit/sec or 128kbit/sec |

# COM (2)


Rx
ADF7021
ULg frequency
GMSK
ADF7021
User frequency
GMSK
OBC
TC
D-STAR
routines
Adaptive
freq.
ADF7021
Ampli
Tx



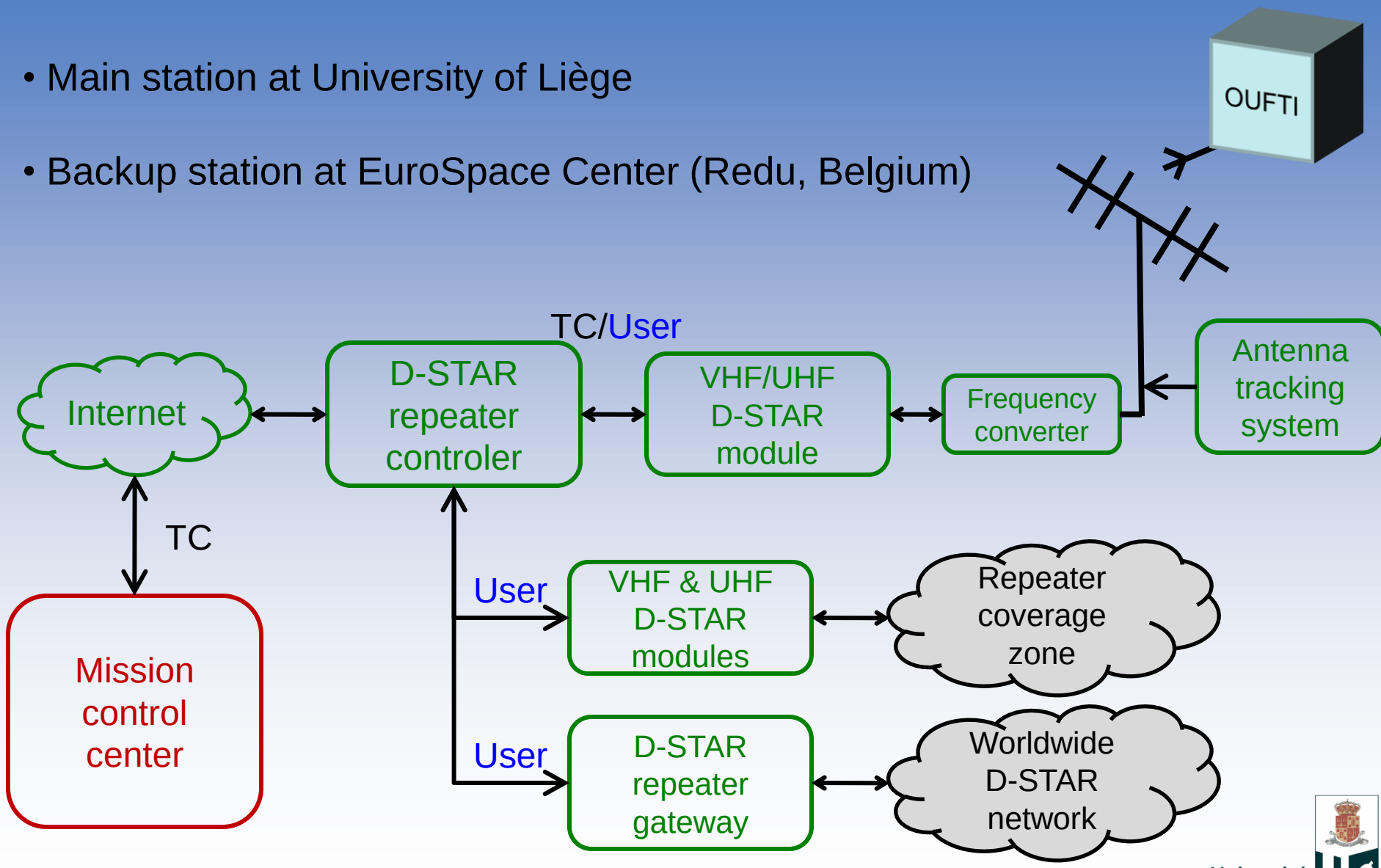
# BCN




- 2 modes
  - CW (12 direct measurements)
  - AX.25 (4800 bauds from OBC)
- Test in progress
- GENSO compatible

# GND

- Main station at University of Liège
- Backup station at EuroSpace Center (Redu, Belgium)



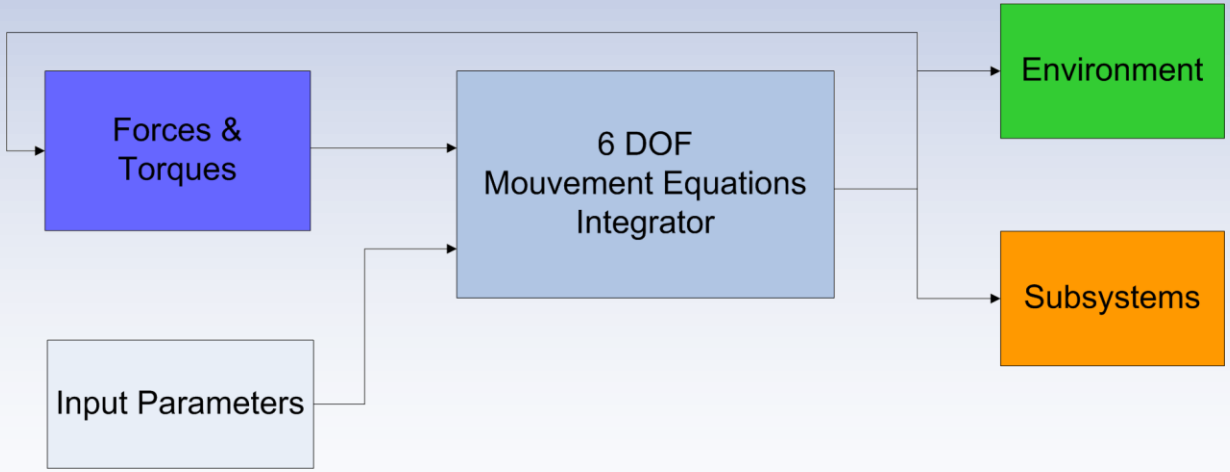
# Simulator

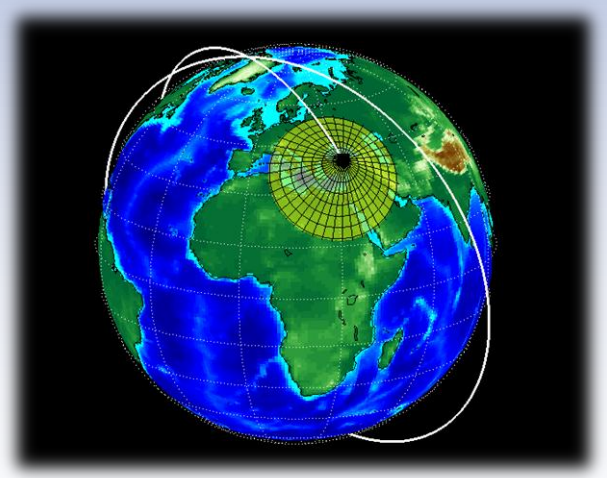
**Simulation of CubeSat in *Simulink***

- High-precision orbit propagation
- Sunlight periods and access to ground station
- STK validation

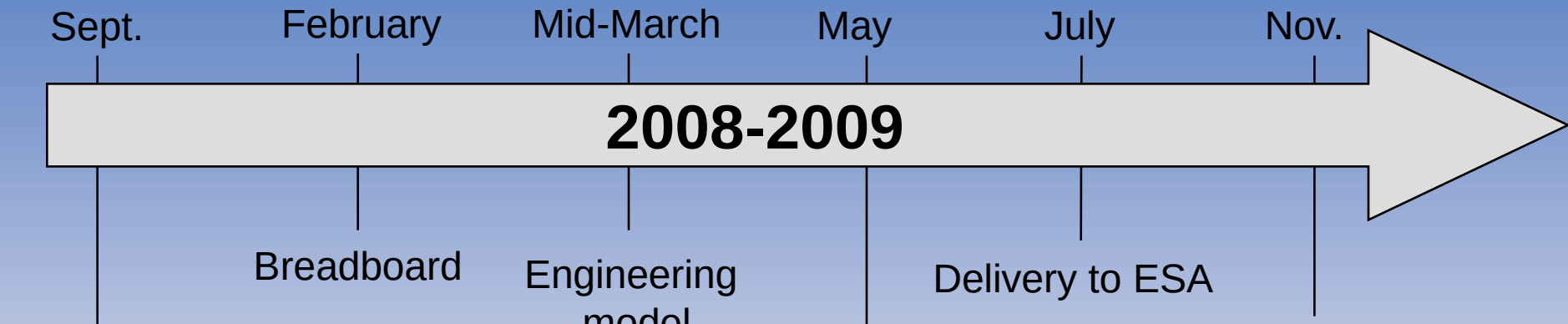
**Goal:** Operational simulator

⇒ Include subsystem models (ADCS, EPS, COM, & THER)



# Timeline


Sept.
February
Mid-March
May
July
Nov.
2008-2009
New team of 13 students
Breadboard
Engineering model
Flight model to be test
Delivery to ESA
VEGA Maiden flight

# Conclusions (1)

- **Mission & use of D-STAR in Space fully defined**

- **Space segment :**
  - Coding and decoding of D-STAR on MSP430 demonstrated
  - All subsystems in various phases of design & construction
  - Breadboard & engineering models on track
  - Tests scheduled for May 2009 at Centre Spatial de Liège

- **Ground segment :**
  - Tracking station fully designed
  - Critical equipments ordered
  - Link from mission control center to D-STAR repeater proven feasible
  - Mission control center under development

# Conclusions (2)

- Many inovative ideas:
  - Use of D-STAR in space
  - redudant OBCs, BCN
  - experimental digital EPS
- Tight schedule
- 13 students and 6 academics
- Strong academic, amateur-radio & industrial support

# And worldwide visibility !

ウェブリブログトップ/ログイン　[新規登録キャンペーン実施中]　トップ　プロフィール　フレンドリスト　サークルリスト

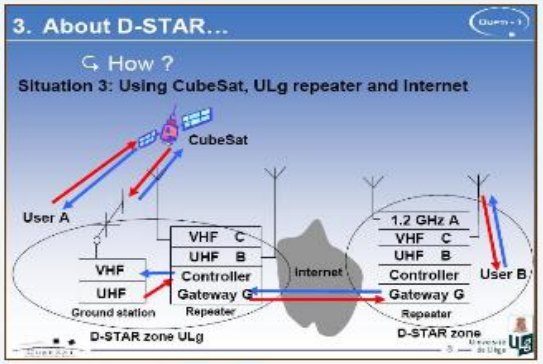
D-STAR技術情報


「CubeSatのOUFTI-1でD-STARプロトコルを使用」について

RSS help

<< 作成日時：2008/06/08 23:05 >>

トラックバック 0 / コメント 0




「CubeSatのOUFTI-1でD-STARプロトコルを使用」について
詳細が下記URLのpdfファイルに出ています。（上記図は、下記URLの8ページ目です。）

http://atl.calpoly.edu/~bklofas/Presentations/DevelopersWorkshop2008/session1/6-Oufti1-Amandine_Denis.pdf

アップリンクとダウンリンクの周波数が分かりませんので日本上空を飛ぶときに交信できるかどうかは不明ですが、使用できれば広範囲な交信が出来そうです。

# Thanks for your attention !

# Contacts

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Amandine.Denis@ulg.ac.be

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OUFTI-1, the first Belgian nanosatellite:

http://www.oufti.ulg.ac.be